

Portable Android Dari and Pashto Soft Keyboard

by Michael Lee

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14. ABSTRACT <p>This report describes the process of creating a portable Dari and Pashto soft keyboard for an Android device using an open-source platform called AnySoftKeyboard. The keyboard layout extensible markup language (XML) files that define the Dari and Pashto keyboards are described and included as appendixes in this report.</p>					
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1. Introduction

Google's Android is the most widely adopted mobile device operating system (OS) in the world. By the 1st quarter of 2012, Android was installed on 59.1% of all mobile phones (followed by Apple's iOS with 23.0%) (1). The popularity of Android is attributed to its free open-source development model and rich set of features for the application ("app") developers. In 2012, the U.S. Army Research Laboratory (ARL) developed an Android app called the Medical Phrasebook to serve as a bilingual English-Dari glossary of more than 6000 technical medical terms (2). The Medical Phrasebook was a simple app. It allows a user to type an English phrase using an English soft keyboard (figure 1) to look up a Dari translation. Similarly, the user would type a Dari phrase into the app to look up an English translation. The Dari text input method was an area of concern.

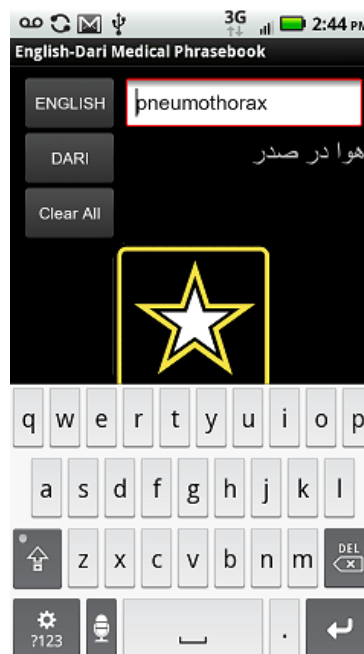


Figure 1. Android's English soft keyboard for entering English terms.

Android provides wide selection of keyboards for many predominant foreign languages (e.g., Arabic, French, German, Hindi, Persian, Vietnamese, etc.) and even some lesser-used languages (e.g., Catalan, Esperanto, Icelandic, Kirghiz, Malay, etc.). However, the Android OS does not provide an input method for Dari characters and there are no third-party soft keyboards that support Dari. As a result, ARL developed and integrated a custom Dari virtual keyboard with the Medical Phrasebook app (figure 2). The custom Dari virtual keyboard was sufficient for the Medical Phrasebook app, but it was not a real Android soft keyboard, meaning that it was not

exportable and other developers could not use ARL's Dari keyboard in their app (without heavily refactoring their source code to integrate the virtual keyboard).

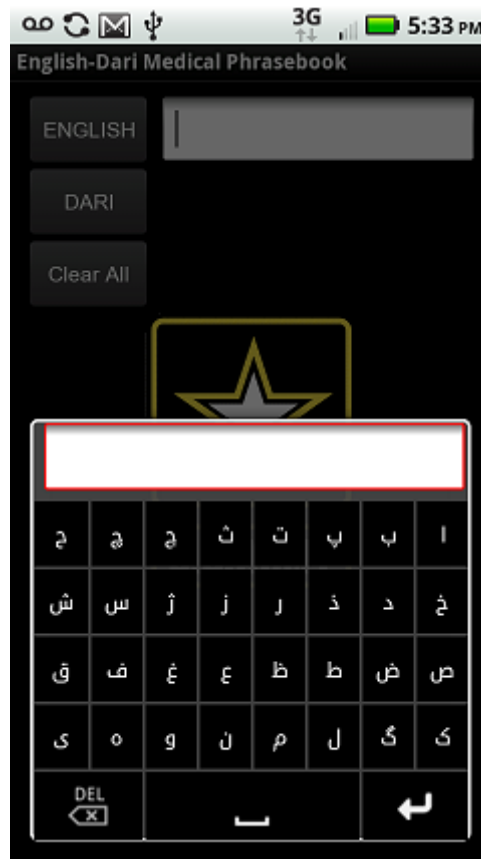


Figure 2. ARL's virtual Dari keyboard for entering Dari terms.

This report describes how ARL re-approached the Dari text input method and created a reusable Android Dari soft keyboard using an open-source platform.

2. AnySoftKeyboard

AnySoftKeyboard (figure 3) is a popular Android soft keyboard and an open-source platform (3) that can be used to build additional language packs. It is ideal for a general user searching for a soft keyboard alternative to Google's built-in soft keyboard as AnySoftKeyboard is freely available for download from Google's app store (4). In addition to rich features built into AnySoftKeyboard for general users, the keyboard is also highly customizable and extensible to additional languages. This flexibility is one of the main reasons why Android developers are drawn to AnySoftKeyboard. Many developers have already used AnySoftKeyboard to create language packs for lesser-used languages (e.g., Devangari, Tamil, Persian, Kannada, Sindhi, Telugu, etc.) for the Android community.

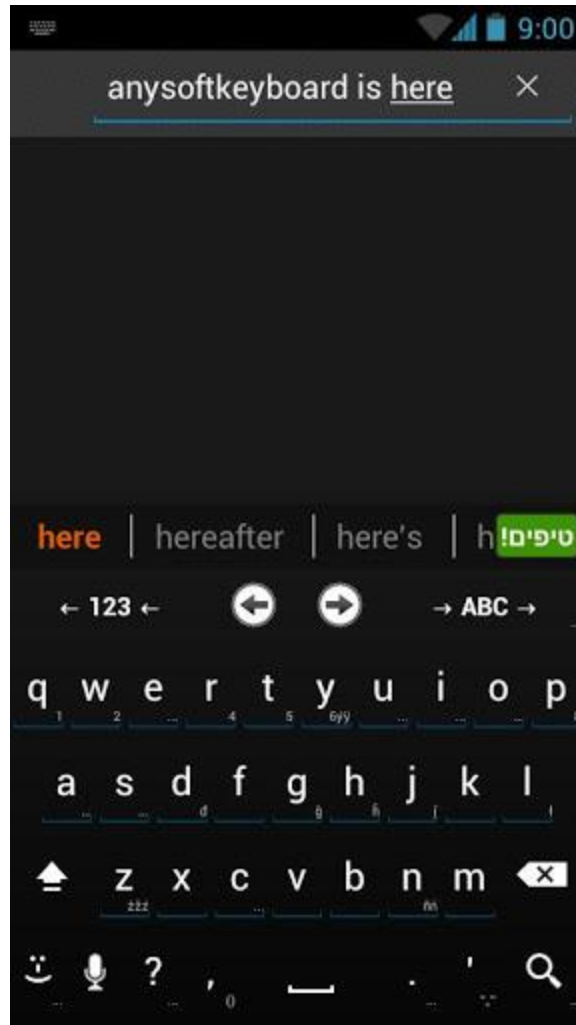


Figure 3. Example of AnySoftKeyboard layout.

3. Creating AnySoftKeyboard Language Packs

Adding a new keyboard to AnySoftKeyboard is referred to as adding a new “Language Pack.” In order to create a new language pack for AnySoftKeyboard, a new Android project must be created in Eclipse Integrated Development Environment (IDE) (figure 4). To facilitate this process, the creators of AnySoftKeyboard have developed an easily modifiable language pack template for new keyboards. The template project is available for download from <https://github.com/AnySoftKeyboard/LanguagePack>. Once the template is downloaded, the user can import it into Eclipse as a new Android project. Since the project is a template, basic name changes need to be made. As such, the project should be renamed to a suitable name (e.g., AnySoftKeyboardLanguagePackPashto) and default package name changed from “com.anysoftkeyboard.languagepack.change_me” to reflect the new project (e.g.,

com.anysoftkeyboard.languagepack.pashto). The new package name must also be updated in two places in the project's AndroidManifest.xml file. Figure 5 shows an example of an updated AndroidManifest.xml (the full file is in appendix A).

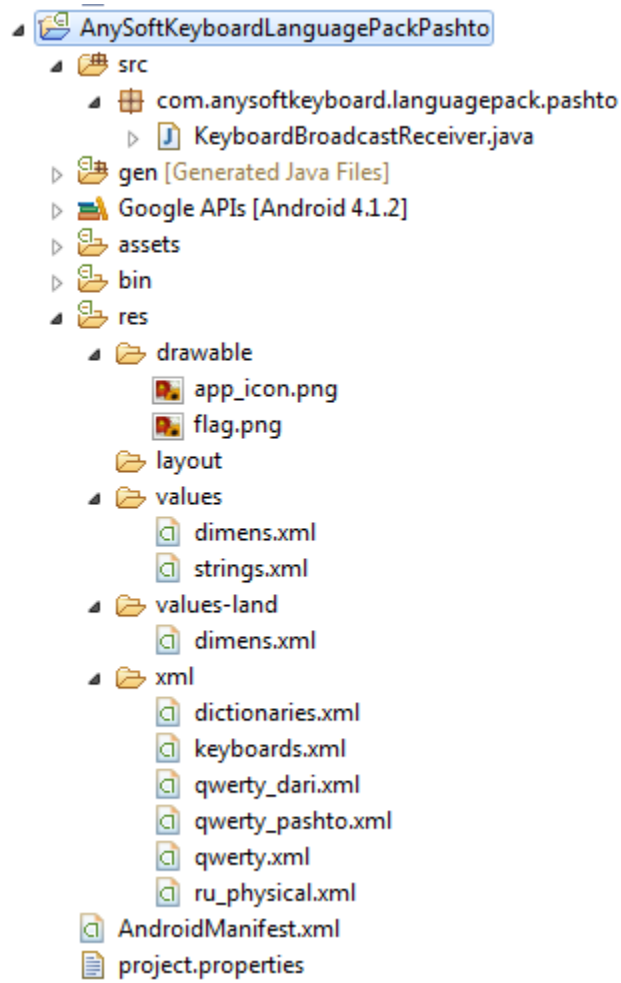


Figure 4. AnySoftKeyboard language pack template imported to Eclipse IDE as an Android project.

```

<?xml version="1.0" encoding="utf-8"?>
<manifest xmlns:android="http://schemas.android.com/apk/res/android"
    package="com.anysoftkeyboard.Languagepack.pashto"
    android:versionCode="0"
    android:versionName="20100426-i-want-to-share">
    <application android:icon="@drawable/app_icon" android:label="@string/app_name">
        <receiver android:exported="true" android:name="com.anysoftkeyboard.Languagepack.pashto.KeyboardBroadcastReceiver">
            <intent-filter>
                <action android:name="com.menny.android.anysoftkeyboard.KEYBOARD" />
                <category android:name="android.intent.category.DEFAULT" />
                <category android:name="android.intent.category.ALTERNATIVE" />
                <category android:name="android.intent.category.SELECTED_ALTERNATIVE" />
            </intent-filter>
            <intent-filter>
                <action android:name="com.menny.android.anysoftkeyboard.DICTIONARY" />
                <category android:name="android.intent.category.DEFAULT" />
                <category android:name="android.intent.category.ALTERNATIVE" />
                <category android:name="android.intent.category.SELECTED_ALTERNATIVE" />
            </intent-filter>
            <meta-data android:name="com.menny.android.anysoftkeyboard.keyboards" android:resource="@xml/keyboards" />
            <meta-data android:name="com.menny.android.anysoftkeyboard.dictionaries" android:resource="@xml/dictionaries" />
        </receiver>
    </application>
    <uses-sdk android:minSdkVersion="3" android:targetSdkVersion="4"></uses-sdk>

    <supports-screens
        android:largeScreens="true"
        android:normalScreens="true"
        android:smallScreens="true"
        android:anyDensity="true" />
    <!-- http://d.android.com/guide/practices/screens_support.html read about legacy. -->
</manifest>

```

Figure 5. AndroidManifest.xml updated with the new package name (circled).

For each new keyboard, a new extensible markup language (XML) keyboard layout file must be created in the “res/xml” folder. The layout file(s) are the center of the project and define all aspects of the keyboard: number of rows of keys, number of keys in each row, primary Unicode value of each key, alternate Unicode values of each key, etc. This Android project has two user-defined layout files; one for Dari and one for Pashto (please see appendix B for the Dari keyboard layout file and appendix C for the Pashto keyboard layout file). Existing resources in the Android open-source community were reused when possible. Persian is an open-source language module available for AnySoftKeyboard, and the Persian keyboard is suitable for Dari text. This open-source Persian module (5) was used to build the Dari layout file. The Pashto layout file was designed by an ARL Dari/Pashto linguist to duplicate the layout on a physical Pashto keyboard (please see section 4 for details on how to create a keyboard layout file).

Once the keyboard layout files are prepared, they must be registered in the keyboards.xml file located in the “res/xml” folder so that AnySoftKeyboard is aware of the available keyboards to list for the user. The template project is shipped with a template keyboards.xml that includes a sample entry. We added two “keyboard” elements to keyboards.xml to encompass the Dari and Pashto keyboards (figure 6). Most attributes of the keyboard element are self-explanatory. The “id” attribute specifies the universally unique identifier (UUID) to use as the keyboard identifier (an online tool [6] is available for generating UUIDs); the “layoutResId” and “landscapeResId” attributes specify the keyboard XML file that defines the current keyboard layout; and the “defaultDictionaryLocal” attribute specifies the two character language code for the keyboard (e.g., Dari = “fa”, Pashto = “ps”). Please see appendix D for the final keyboards.xml used for this

project. The user completes the project by generating an Android application package (APK) file and deploying it to an Android device. Note that this APK file is not an independent runnable app and is not launched like a typical app. Please see section 5 for details on how to enable the Dari and Pashto keyboards.

```
<Keyboard
id="d8adedae-3fd1-464c-96ce-edf8df04d379"
nameResId="@string/keyboard_pashto"
layoutResId="@xml/qwerty_pashto"
landscapeResId="@xml/qwerty_pashto"
iconResId="@drawable/flag"
defaultDictionaryLocale="ps"
description="Pashto keyboard. ARL"
index="2"/>

<Keyboard
id="f4f9571c-7383-4b20-913f-182b56f6547e"
nameResId="@string/keyboard_dari"
layoutResId="@xml/qwerty_dari"
landscapeResId="@xml/qwerty_dari"
iconResId="@drawable/flag"
defaultDictionaryLocale="fa"
description="Dari keyboard. ARL"
index="3"/>
```

Figure 6. Pashto and Dari keyboard entries in keyboards.xml

4. Keyboard Layout XML File

The keyboard layout XML files are the most important files in the project. A keyboard layout file must be created in the “res/xml” folder for each keyboard. A sample keyboard layout file, `qwerty.xml`, included with the template project can be used as a starting point or renamed. The layout file can be named any filename, but the filename cannot contain uppercase letters. A filename such as “`qwerty_Pashto.xml`” will throw an exception.

Creating the layout file is simple and intuitive. The visual layout of the keyboard is primarily defined using the “Row” and “Key” XML elements. For example, to create a keyboard with 3 rows, with each row containing 10 keys, the layout file will have 3 “Row” XML elements and each “Row” element will have 10 “Key” elements as children (figure 7). The “Key” element is where a character is defined and mapped. The “Key” element has three main attributes to define its functionality: “`android:codes`”, “`android:keyLabel`”, and “`android:popupCharacters`”. All three attributes are placeholders for Decimal Unicode (not to be mistaken with the more commonly used Hexadecimal Unicode). Decimal Unicode value is preceded by “`&#`” and ends with “`;`” character. Every character has a hexadecimal Unicode and decimal Unicode—it is very

important to enter the decimal Unicode values for these attributes. For example, the Arabic character “Gaf” has hexadecimal Unicode value 0x06AF and decimal Unicode value 1711. The “android:keyLabel” attribute is a visual indicator of the letter, it specifies what character is superimposed on top of the keyboard key. The “android:codes” attribute specifies the character that is entered (in a text field) when a user presses the key. In most cases, “android:codes” and “android:keyLabel” attributes will have the same decimal Unicode values. If desired, “android:codes” and “android:keyLabel” attributes can have different values without raising compilation errors. Finally, the “android:popupCharacters” attribute specifies alternate characters for the key. A typical U.S. keyboard has one alternate character for each key, but AnySoftkeyboard allows many alternate characters for each key. Alternate characters are defined by concatenating decimal Unicodes in the “android:popupCharacters” attribute. A user can display list of alternate choices by pressing down on the key (figure 8). Please see appendix B for the Dari keyboard layout XML file and appendix C for the Pashto keyboard layout XML file.

```
<Row android:keyWidth="10%p">
  <Key android:codes="1592" android:keyLabel="&#1592;" android:popupCharacters="&#1574;" android:keyEdgeFlags="Left"/>
  <Key android:codes="1591" android:keyLabel="&#1591;" android:popupCharacters="&#1744;" />
  <Key android:codes="1586" android:keyLabel="&#1586;" android:popupCharacters="&#1688;" />
  <Key android:codes="1585" android:keyLabel="&#1585;" android:popupCharacters="&#1569;" />
  <Key android:codes="1584" android:keyLabel="&#1584;" android:popupCharacters="&#8204;" />
  <Key android:codes="1583" android:keyLabel="&#1583;" android:popupCharacters="&#1673;" />
  <Key android:codes="1683" android:keyLabel="&#1683;" android:popupCharacters="&#1572;" />
  <Key android:codes="1608" android:keyLabel="&#1608;" android:popupCharacters="&#1548;,&#0060;" />
  <Key android:codes="1686" android:keyLabel="&#1686;" android:popupCharacters="&#0046;>" />
  <Key android:codes="0047" android:keyLabel="/" android:popupCharacters="&#1567;?" android:keyEdgeFlags="right"/>
</Row>
```

Figure 7. Example of a “Row” element containing 10 “Key” elements.



Figure 8. List of alternate available characters for the selected key.

5. Activating Dari and Pashto Soft Keyboards

The Dari and Pashto soft keyboards are extensions of AnySoftKeyboard and therefore require the main AnySoftKeyboard app (which is found in the Google app store). The user should open the AnySoftKeyboard's settings page and then select the "Keyboards" option found under the "Languages" section (figure 9). The "Keyboards" page allows the user to specify what keyboard layouts to activate. A list of available keyboard layouts is displayed (figure 10).



Figure 9. AnySoftKeyboard's settings page.

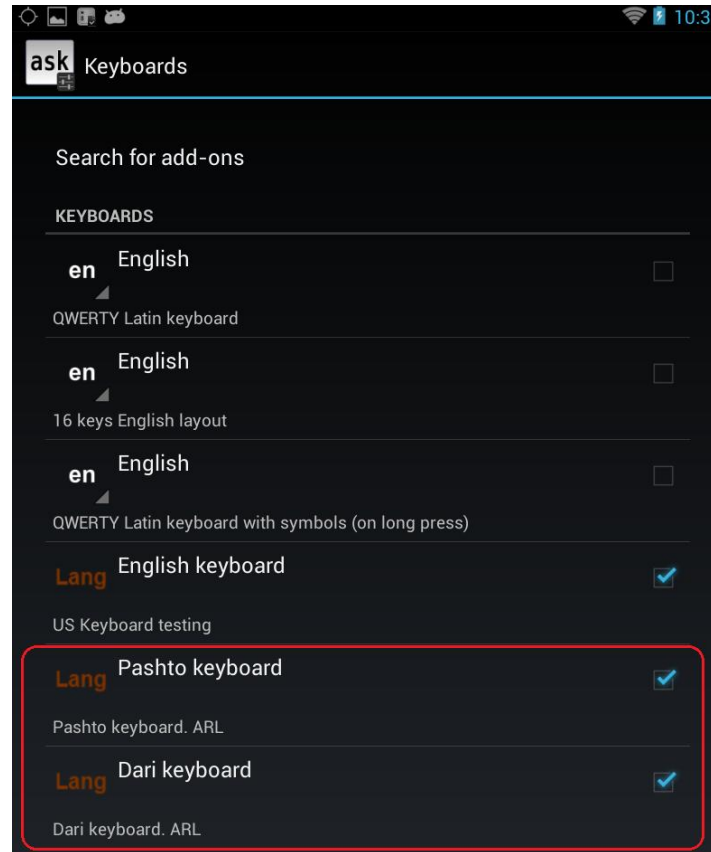


Figure 10. List of available keyboard layouts recognized by AnySoftKeyboard.

To enable the Dari and Pashto layouts, select “Dari Keyboard” and “Pashto keyboard.” Go to the Android device’s “Language & input” settings page and set AnySoftKeyboard as the device’s default keyboard (figure 11). The Dari (figure 12) and Pashto (figure 13) soft keyboards are now activated. When a user focuses on any text field, AnySoftKeyboard now appears by default. To switch to other available keyboards, click on the keyboard selector button (located on the top-right-most corner of the keyboard) to cycle through the keyboards or hold down the keyboard selector button to see a pop-up dialog box (figure 14) that lists the available keyboards to choose from. The current keyboard is identified by the label on the space bar. For example, the Pashto keyboard will have the text “Pashto Keyboard” on the spacebar.

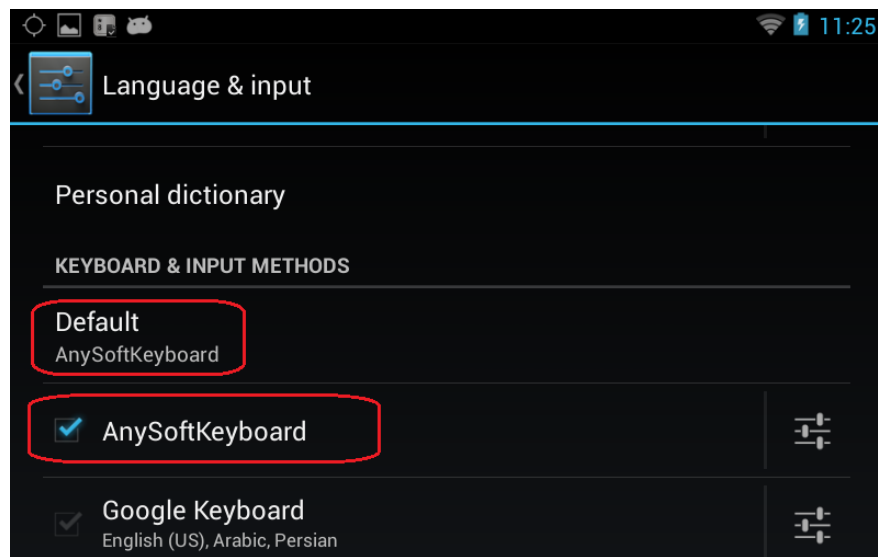


Figure 11. Set AnySoftKeyboard as the device's default keyboard.



Figure 12. Dari soft keyboard.



Figure 13. Pashto soft keyboard.

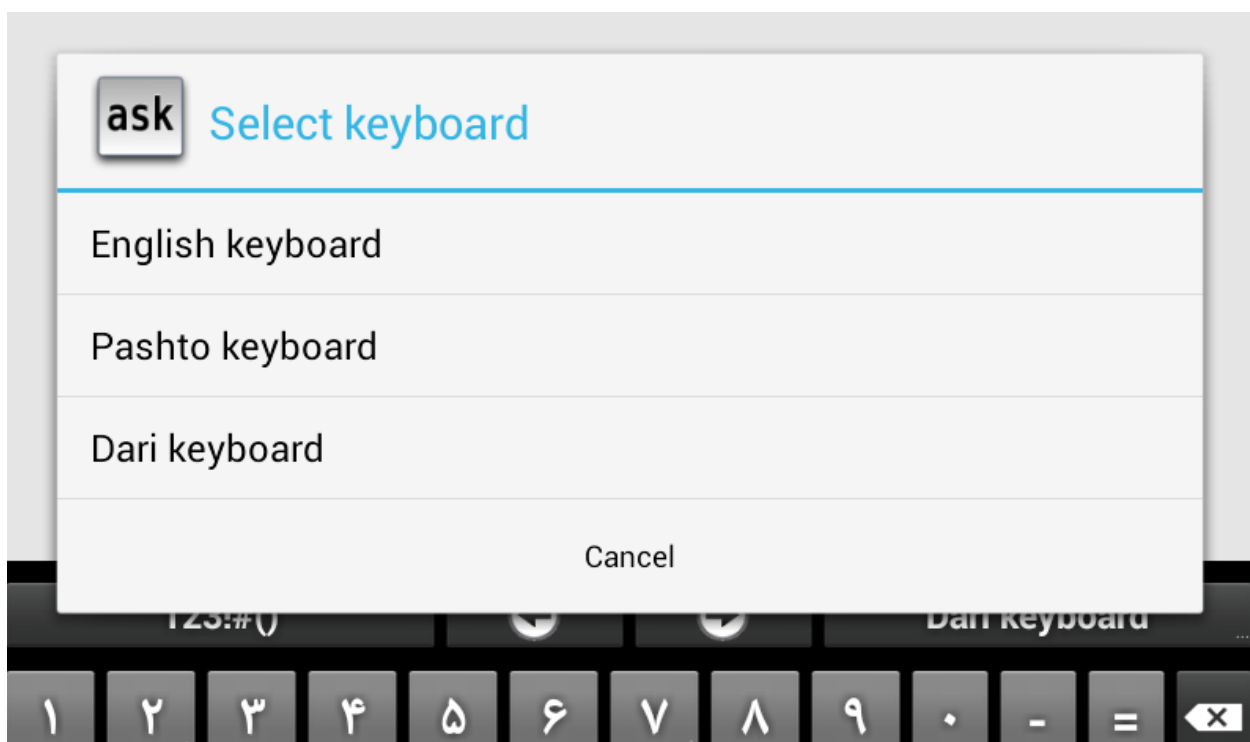


Figure 14. Pop-up dialog box that lists available keyboards to choose from.

6. Conclusion

Previously, there was no way to enter Dari or Pashto characters in an Android app. As an initial attempt, ARL created a custom virtual Dari keyboard with the Medical Phrasebook app, but it was hardwired into the app and was not exportable to other developers in the Android community. ARL addressed this limitation with the updated version of the Medical Phrasebook app (figure 15) using an open-source keyboard platform called AnySoftKeyboard. The new Dari and Pashto soft keyboards are now a light and exportable app that gives any Android device the ability to enter Dari and Pashto characters without adding complexities of handling Dari/Pashto characters in the app.

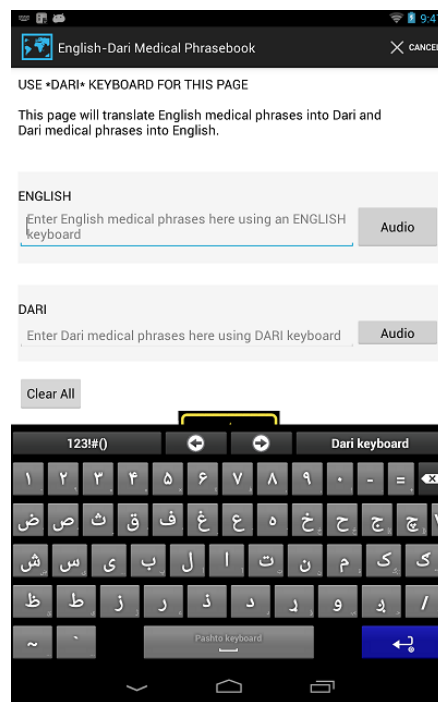


Figure 15. New Medical Phrasebook app using the AnySoftKeyboard extensions.

7. References

1. Android and iOS Combine for 92.3% of All Smartphone Operating System Shipments in the First Quarter While Windows Phone Leapfrogs BlackBerry, According to IDC. <http://www.idc.com/getdoc.jsp?containerId=prUS24108913> (accessed June 2013).
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4. AnySoftKeyboard download page. <https://play.google.com/store/apps/details?id=com.menny.android.anysoftkeyboard&hl=en> (accessed June 2013).
5. Persian for AnySoftKeyboard. <https://play.google.com/store/apps/details?id=com.anysoftkeyboard.languagepack.persian&hl=en> (accessed July 2013).
6. UUID Generator. <http://www.famkruithof.net/uuid/uuidgen> (accessed July 2013).

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Appendix A. AndroidManifest.xml

The following is the AndroidManifest.xml file.

```
<?xml version="1.0" encoding="utf-8"?>
<manifest xmlns:android="http://schemas.android.com/apk/res/android"
    package="com.anysoftkeyboard.languagepack.pashto"
    android:versionCode="0"
    android:versionName="20100426-i-want-to-share">
    <application android:icon="@drawable/app_icon" android:label="@string/app_name">
        <receiver android:exported="true"
            android:name="com.anysoftkeyboard.languagepack.pashto.KeyboardBroadcastReceiver">
            <intent-filter>
                <action android:name="com.menny.android.anysoftkeyboard.KEYBOARD" />
                <category android:name="android.intent.category.DEFAULT" />
                <category android:name="android.intent.category.ALTERNATIVE" />
                <category android:name="android.intent.category.SELECTED_ALTERNATIVE" />
            </intent-filter>
            <intent-filter>
                <action android:name="com.menny.android.anysoftkeyboard.DICTIONARY" />
                <category android:name="android.intent.category.DEFAULT" />
                <category android:name="android.intent.category.ALTERNATIVE" />
                <category android:name="android.intent.category.SELECTED_ALTERNATIVE" />
            </intent-filter>
            <meta-data android:name="com.menny.android.anysoftkeyboard.keyboards"
                android:resource="@xml/keyboards" />
            <meta-data android:name="com.menny.android.anysoftkeyboard.dictionaries"
                android:resource="@xml/dictionaries" />
        </receiver>
    </application>
    <uses-sdk android:minSdkVersion="3" android:targetSdkVersion="4"></uses-sdk>

    <supports-screens
        android:largeScreens="true"
        android:normalScreens="true"
        android:smallScreens="true"
        android:anyDensity="true" />
    <!-- http://d.android.com/guide/practices/screens_support.html read about legacy. -->
</manifest>
```

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Appendix B. qwerty_dari.xml

The following is the Dari keyboard file.

```
<?xml version="1.0" encoding="utf-8"?>
<Keyboard xmlns:android="http://schemas.android.com/apk/res/android"
xmlns:ask="http://schemas.android.com/apk/res/com.anysoftkeyboard.Languagepack.pashto"
"
    android:keyWidth="10%p"
    android:horizontalGap="0px"
    android:verticalGap="0px"
    android:keyHeight="@dimen/key_height"
  >
    <Row android:keyWidth="10%p">
      <Key android:codes="1590" android:keyLabel="#1590;"
android:popupCharacters="#1776;" android:keyEdgeFlags="left"/>
      <Key android:codes="1589" android:keyLabel="#1589;"
android:popupCharacters="#1777;"/>
      <Key android:codes="1602" android:keyLabel="#1602;"
android:popupCharacters="#1778;"/>
      <Key android:codes="1601" android:keyLabel="#1601;"
android:popupCharacters="#1779;"/>
      <Key android:codes="1594" android:keyLabel="#1594;"
android:popupCharacters="#1780;"/>
      <Key android:codes="1593" android:keyLabel="#1593;"
android:popupCharacters="#1781;"/>
      <Key android:codes="1607" android:keyLabel="#1607;"
android:popupCharacters="#1782;"/>
      <Key android:codes="1582" android:keyLabel="#1582;"
android:popupCharacters="#1783;"/>
      <Key android:codes="1581" android:keyLabel="#1581;"
android:popupCharacters="#1784;"/>
      <Key android:codes="1580" android:keyLabel="#1580;"
android:popupCharacters="#1785;" android:keyEdgeFlags="right"/>
    </Row>
    <Row android:keyWidth="10%p">
      <Key android:codes="1588" android:keyLabel="#1588;"
android:keyEdgeFlags="left"/>
      <Key android:codes="1587" android:keyLabel="#1587;"
android:popupCharacters="#1642;"/>
      <Key android:codes="1740" android:keyLabel="#1740;"
android:popupCharacters="#1574;#1610;"/>
      <Key android:codes="1576" android:keyLabel="#1576;"/>
      <Key android:codes="1604" android:keyLabel="#1604;"/>
      <Key android:codes="1575" android:keyLabel="#1575;"
android:popupCharacters="#1570;"/>
      <Key android:codes="1578" android:keyLabel="#1578;"/>
      <Key android:codes="1606" android:keyLabel="#1606;"/>
      <Key android:codes="1605" android:keyLabel="#1605;"/>
      <Key android:codes="1705" android:keyLabel="#1705;"
android:popupCharacters="#1711;" android:keyEdgeFlags="right"/>
    </Row>
```

```

        <Row android:keyWidth="10%p">
            <Key android:codes="1592" android:keyLabel="#1592;"
android:keyEdgeFlags="left"/>
            <Key android:codes="1591" android:keyLabel="#1591;"/>
            <Key android:codes="1586" android:keyLabel="#1586;"
android:popupCharacters="#1688;"/>
            <Key android:codes="1585" android:keyLabel="#1585;"/>
            <Key android:codes="1584" android:keyLabel="#1584;"/>
            <Key android:codes="1583" android:keyLabel="#1583;"/>
            <Key android:codes="1608" android:keyLabel="#1608;"
android:popupCharacters="#1572;"/>
            <Key android:codes="1670" android:keyLabel="#1670;"/>
            <Key android:codes="-5" android:keyEdgeFlags="right" android:keyWidth="20%p"
android:isRepeatable="true"/>
        </Row>
        <Row android:rowEdgeFlags="bottom">
            <Key android:codes="1567" android:keyLabel="#1567;"
android:popupCharacters="_-?" android:keyEdgeFlags="left"/>
            <Key android:codes="1548" android:keyLabel="#1548;"
android:popupCharacters=", "/>
            <Key android:codes="46" android:keyLabel="."
android:popupCharacters="#1563;;" />
            <Key android:codes="32" android:keyWidth="35%p"/>
            <Key android:codes="65163" android:keyLabel="#65163;"
android:popupCharacters="#1569;" android:keyEdgeFlags="right"/>
            <Key android:codes="1662" android:keyLabel="#1662;"
android:popupCharacters="#1579;"/>
            <Key android:codes="10" android:keyWidth="15%p"
android:keyEdgeFlags="right"/>
        </Row>
    </Keyboard>

```

Appendix C. qwerty_pashto.xml

The following is the Pashto keyboard file.

```
<?xml version="1.0" encoding="utf-8"?>
<Keyboard xmlns:android="http://schemas.android.com/apk/res/android"
xmlns:ask="http://schemas.android.com/apk/res/com.anysoftkeyboard.Languagepack.pashto"
"
    android:keyWidth="10%p"
    android:horizontalGap="0px"
    android:verticalGap="0px"
    android:keyHeight="@dimen/key_height"
  >
    <Row android:keyWidth="8%p">
      <Key android:codes="1777" android:keyLabel="#1777;"
android:popupCharacters="#1776;" android:keyEdgeFlags="left"/>
      <Key android:codes="1778" android:keyLabel="#1778;"
android:popupCharacters="#1785;"/>
      <Key android:codes="1779" android:keyLabel="#1779;"
android:popupCharacters="#0187;"/>
      <Key android:codes="1780" android:keyLabel="#1780;"
android:popupCharacters="#0171;"/>
      <Key android:codes="1781" android:keyLabel="#1781;"
android:popupCharacters="#0215;"/>
      <Key android:codes="1782" android:keyLabel="#1782;"
android:popupCharacters="#1642;"/>
      <Key android:codes="1783" android:keyLabel="#1783;"
android:popupCharacters="#1547;"/>
      <Key android:codes="1784" android:keyLabel="#1784;"
android:popupCharacters="#1643;"/>
      <Key android:codes="1785" android:keyLabel="#1785;"
android:popupCharacters="#1644;"/>
      <Key android:codes="1776" android:keyLabel="#1776;"
android:popupCharacters="#0033;" android:keyWidth="7%p" />
      <Key android:codes="0045" android:keyLabel="-"
android:popupCharacters="#1600;" android:keyWidth="7%p"/>
      <Key android:codes="0061" android:keyLabel="="
android:popupCharacters="+" android:keyWidth="7%p"/>
      <Key android:codes="-5" android:isRepeatable="true"
android:keyWidth="7%p" android:keyEdgeFlags="right"/>
    </Row>
    <Row android:keyWidth="8%p">
      <Key android:horizontalGap="0%p" android:codes="1590"
android:keyLabel="#1590;" android:popupCharacters="#1618;"
android:keyEdgeFlags="left"/>
      <Key android:codes="1589" android:keyLabel="#1589;"
android:popupCharacters="#1612;"/>
      <Key android:codes="1579" android:keyLabel="#1579;"
android:popupCharacters="#1613;"/>
      <Key android:codes="1602" android:keyLabel="#1602;"
android:popupCharacters="#1611;"/>
      <Key android:codes="1601" android:keyLabel="#1601;"
```

```

android:popupCharacters="&#1615;"/>
    <Key android:codes="1594" android:keyLabel="&#1594;"
android:popupCharacters="&#1616;"/>
    <Key android:codes="1593" android:keyLabel="&#1593;"
android:popupCharacters="&#1614;"/>
    <Key android:codes="1607" android:keyLabel="&#1607;"
android:popupCharacters="&#1617;"/>
    <Key android:codes="1582" android:keyLabel="&#1582;"
android:popupCharacters="&#1665;"/>
    <Key android:codes="1581" android:keyLabel="&#1581;"
android:popupCharacters="&#1669;"/>
    <Key android:codes="1580" android:keyLabel="&#1580;"
android:popupCharacters="&#0091;{"/>
    <Key android:codes="1670" android:keyLabel="&#1670;"
android:popupCharacters="&#0093;}/>
    <Key android:codes="0092" android:keyLabel="&#0092;"
android:popupCharacters="&#0042;|" android:keyWidth="4%p"
android:keyEdgeFlags="right"/>
</Row>
<Row android:keyWidth="9%p">
    <Key android:codes="1588" android:keyLabel="&#1588;"
android:popupCharacters="&#1690;" android:keyEdgeFlags="left"/>
    <Key android:codes="1587" android:keyLabel="&#1587;"
android:popupCharacters="&#1741;"/>
    <Key android:codes="1740" android:keyLabel="&#1740;"
android:popupCharacters="&#1741;&#1610;&#1574;&#1744;"/>
    <Key android:codes="1576" android:keyLabel="&#1576;"
android:popupCharacters="&#1662;"/>
    <Key android:codes="1604" android:keyLabel="&#1604;"
android:popupCharacters="&#1571;"/>
    <Key android:codes="1575" android:keyLabel="&#1575;"
android:popupCharacters="&#1570;"/>
    <Key android:codes="1578" android:keyLabel="&#1578;"
android:popupCharacters="&#1660;"/>
    <Key android:codes="1606" android:keyLabel="&#1606;"
android:popupCharacters="&#1724;"/>
    <Key android:codes="1605" android:keyLabel="&#1605;"
android:popupCharacters="&#1577;"/>
    <Key android:codes="1705" android:keyLabel="&#1705;"
android:popupCharacters="&#0058;&#0059;&#1711;" />
    <Key android:codes="1707" android:keyLabel="&#1707;"
android:popupCharacters="&#1563;'&#0034;" android:keyEdgeFlags="right"/>
</Row>
<Row android:keyWidth="10%p">
    <Key android:codes="1592" android:keyLabel="&#1592;"
android:popupCharacters="&#1574;" android:keyEdgeFlags="left"/>
    <Key android:codes="1591" android:keyLabel="&#1591;"
android:popupCharacters="&#1744;"/>
    <Key android:codes="1586" android:keyLabel="&#1586;"
android:popupCharacters="&#1688;"/>
    <Key android:codes="1585" android:keyLabel="&#1585;"
android:popupCharacters="&#1569;"/>
    <Key android:codes="1584" android:keyLabel="&#1584;"
android:popupCharacters="&#8204;"/>
    <Key android:codes="1583" android:keyLabel="&#1583;"

```

```

android:popupCharacters="&#1673;" />
    <Key android:codes="1683" android:keyLabel="&#1683;"
android:popupCharacters="&#1572;" />
    <Key android:codes="1608" android:keyLabel="&#1608;"
android:popupCharacters="&#1548;, &#0060;" />
    <Key android:codes="1686" android:keyLabel="&#1686;"
android:popupCharacters="&#0046;" />
    <Key android:codes="0047" android:keyLabel="/"
android:popupCharacters="&#1567;?" android:keyEdgeFlags="right" />
</Row>
<Row android:rowEdgeFlags="bottom">
    <Key android:keyWidth="10%p" android:codes="0126"
android:keyLabel="&#0126;" android:popupCharacters="&#0033; \&#0035; &#0036; &#0037;"
android:keyEdgeFlags="left" />
    <Key android:keyWidth="10%p" android:codes="0096" android:keyLabel="`"
android:popupCharacters="&#0094; &#0038; &#0042; &#0040; &#0041;" />
    <Key android:horizontalGap="10%p" android:codes="32"
android:keyWidth="40%p" />
    <Key android:horizontalGap="10%p" android:codes="10" android:keyWidth="20%p"
android:keyEdgeFlags="right" />
</Row>
</Keyboard>

```

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Appendix D. keyboards.xml

The following is the final keyboards.xml file used.

```
<?xml version="1.0" encoding="UTF-8"?>
<Keyboards>
  <Keyboard
    id="038f264f-f757-4d24-b9d7-6b77d508c77c"
    nameResId="@string/keyboard"
    layoutResId="@xml/qwerty"
    landscapeResId="@xml/qwerty"
    physicalKeyboardMappingResId="@xml/ru_physical"
    iconResId="@drawable/flag"
    defaultDictionaryLocale="en"
    description="US Keyboard testing"
    index="1"/>

  <Keyboard
    id="d8adedae-3fd1-464c-96ce-edf8df04d379"
    nameResId="@string/keyboard_pashto"
    layoutResId="@xml/qwerty_pashto"
    landscapeResId="@xml/qwerty_pashto"
    iconResId="@drawable/flag"
    defaultDictionaryLocale="ps"
    description="Pashto keyboard. ARL"
    index="2"/>

  <Keyboard
    id="f4f9571c-7383-4b20-913f-182b56f6547e"
    nameResId="@string/keyboard_dari"
    layoutResId="@xml/qwerty_dari"
    landscapeResId="@xml/qwerty_dari"
    iconResId="@drawable/flag"
    defaultDictionaryLocale="fa"
    description="Dari keyboard. ARL"
    index="3"/>

</Keyboards>
```

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